

# **Spaceflight Medical Evacuation Risk Assessment Principles: *A Qualitative Investigation from Space and Analog Environments***

**Human Research Program  
Exploration Medical Capability Element**

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**“Expanding the Boundaries of Space Medicine and Technology”**

- **Overview**
- **Research Question**
- **Study Objectives**
- **Research Goal**
- **Research Team**
- **Methodology**
- **Status, Preliminary Results/Findings, and Forward Work**

- What unique principles must be considered for medical evacuation (MEDEVAC\*) decisions in extreme environments?

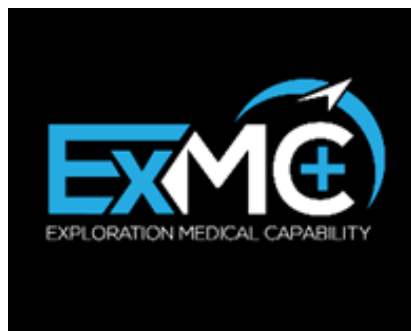
\*MEDEVAC = Medical Evacuation; Distinguished from “CASEVAC” or “casualty evacuation” and “AIREVAC” (formal “aeromedical evacuation”) as described in the military environment

- ID Common principles used to assess risks and benefits of MEDEVAC in extreme environments
- ID common challenges and complications of MEDEVAC in extreme environments

Inform MEDEVAC and medical system design for Moon and Mars



- |                       |                        |   |
|-----------------------|------------------------|---|
| • Austin Almand, MS   | Project Lead           | ExMC Intern / CU-Anschutz MD Candidate                  |
| • Benjamin Easter, MD | Primary Investigator   | ExMC Acting Element Scientist / CU-Anschutz Asst. Prof. |
| • Jonathan Laws, MS   | Qualitative Design SME | Northumbria University PhD Candidate                    |
| • Arian Anderson, MD  | Interviewer / Reviewer | ExMC Clinical and Science Team Physician                |
| • Ryan Keller         | Contributor            | Baylor College of Medicine MD Candidate                 |
| • Michael Zero, MS    | Reviewer               | CU-Boulder PhD Candidate                                |
| • Kris Lehnhardt, MD  | Sponsor                | ExMC Element Scientist / Baylor COM Sen. Faculty        |



## Methodology

- In-depth semi-structured interviews with subject matter experts (SMEs)
- Qualitative *thematic analysis* using *consensus, co-occurrence and comparison*
- Sample sizes follow a *step-wise approach* seeking *saturation* for each analog domain
- Analogs determined by mission, MEDEVAC complexity and local medical capability

## Execution

- SMEs ID'd and invited for a recorded video interview (Zoom, Teams, phone)
- Audio anonymized, transcribed, and analyzed for emerging themes
- Emerging themes and conclusions reviewed by research team for validity

Images (L-to-R) courtesy NASA, US Air Force, US DoE, US Navy, NASA, and Lloyd Smith via the public domain and Creative Commons



## Status

- 18 SME interviews analyzed
  - 2 Alpine/Wilderness
  - 5 Polar
  - 4 Combat
  - 3 Military Submarine
  - 2 Underwater
  - 2 Spaceflight
- 1200+ min of interviews transcribed, coded, analyzed

## Preliminary Results

- 9 MEDEVAC risk consideration themes
- 9 contributing factor themes



*Image courtesy NASA Goddard*



*Image courtesy US Army*



## Primary Risks Themes

- **Patient(s)** – number, stability, expected clinical course
- **Experience** – clinical decision making, team rehearsal
- **Execution** – stability of patient, difficulty of transfer
- **Crew** – during, post MEDEVAC, increased burden
- **Environment** – risks to crew and vehicles, risks over time
- **Mission** – mission viability, Context determines MEDEVAC
- **Time** – transport, execution, stability
- **Medical Provider** – importance, duty, fatigue
- **Resources** – personnel, vehicles, equipment, supplies

*“patient life or lifelong disability , that really is the primary consideration”*

*“we have to not fear death but embrace death and accept death as as a reality . And we're just not there as a society”*

*“don't create more people needing to be rescued”*

*“the resources, the training, the appropriate equipment to make the stay play worthwhile”*

## Contributing Factors Themes

- **Communication** – Reliability, Consistency, Information lost
- **MEDEVAC Planning** – preplanned vs. ad hoc
- **Medical Support Planning** – native, resupply, tiered
- **Offsite Support** – telemedicine, decision support
- **Philosophy** – stay and play vs. load and go
- **Crew Cohesion** – teamwork, interpersonal awareness
- **Political Considerations** – optics, funding
- **Psychological Considerations** – hero complex, psychological fitness, guilt
- **Decision Making** – medical vs. operational decision makers, centralized vs. decentralized

*“The constant rehearsal is a huge one”*

*“I have never been on a single mission or been a part of any mission where any of the information that initially came out was better than 50 percent accurate”*

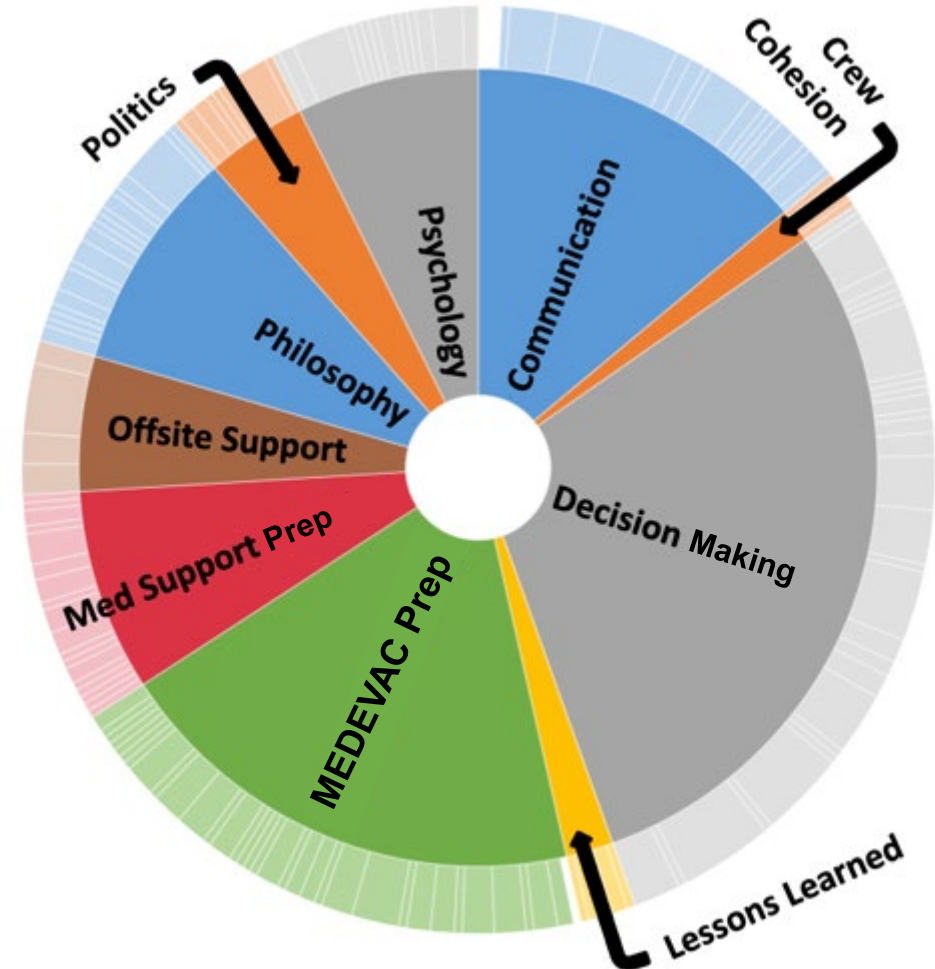
*“Disjunctions happen in small towns, but for the most part, we all get along”*

*“if it had gone wrong, I mean, the stock price could have gone way down”*

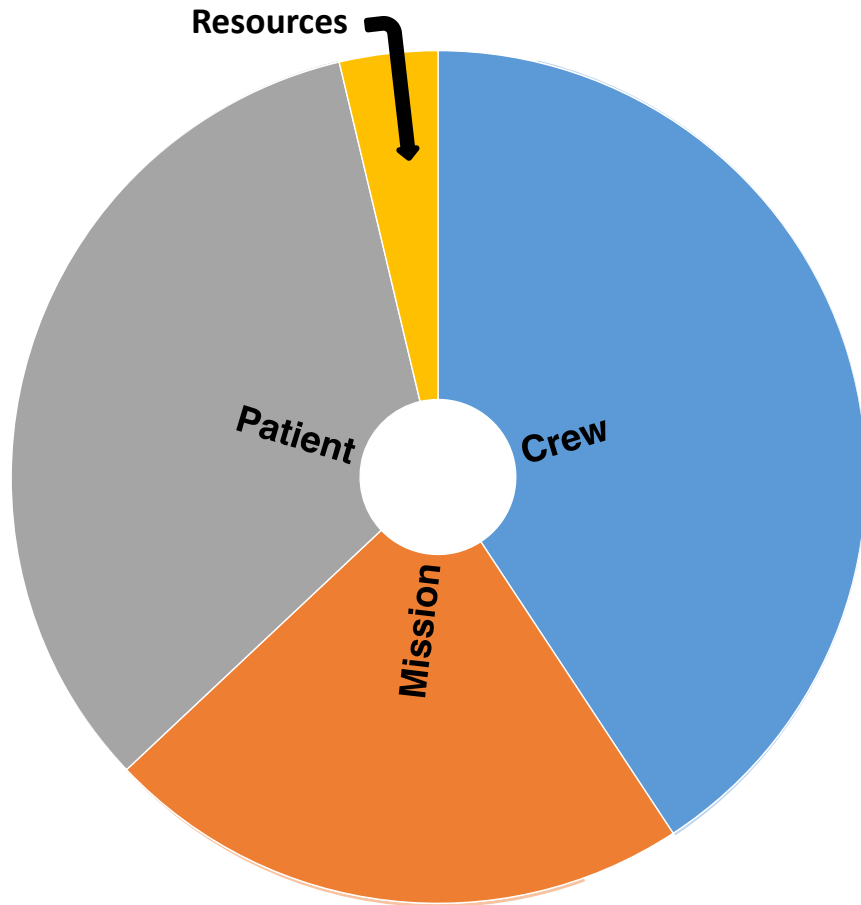
## Primary Risks



## Contributing Factors



## Top Priority Choice for MEDEVAC



*"the highest consequence thing would be to make sure that the evacuation doesn't cross a risk threshold for the providers"*

*"what is in the best interest of the patient with everything else kind of as contributing"*

*"Our mission was so critical that they were essentially accepting that somebody would be lost on their on their watch"*

*"First and foremost, what is the capability of the evac team ?"*



## Takeaways

- Preparation + Philosophy + Decision Making : Set the scene
- Patient(s) + Resources + Experience : The MEDEVAC “math”
- Crew vs. Patient...

## Impacts

- Framework for medical system design and contingency planning
- Inform training and preparation for crew and organization at large
- Tool for real-time MEDEVAC decision support

## Execution

- Complete interviews with SME's in Space domains

## Analysis

- Revise, refine and consolidate findings
- Disseminate to team for review
- Draft and submit manuscript for review/publication

## Application

- Stakeholders discussion
- Define principles for new decision and planning tool

ExMC  
Research Team  
Participants